

12831728

Composite beams

- a) the maximum bending stress in the aluminum bars (ANS. 50.5 MPa)



- bending stress produced in both the wood and the steel if a bending moment of $M_z = +50$ kip-in is



- dimensions of the wood beam are $BW = 140\text{mm}$, $dw = 320\text{mm}$ and its modulus of elasticity is 12 GPa . The CFRP ($E = 165\text{ GPa}$) block has dimensions of $b_c = 80\text{mm}$, and $t = 2\text{mm}$. The shear

has a span of $L = 8\text{ m}$ and it supports two concentrated loads P , which act at the quarter points of the span. The allowable bending stress of the wood and the CFRP are 9 MPa , and 1000 MPa respectively.

Determine the largest acceptable magnitude for the concentrated loads P . (Neglect the weight of the beam in the calculations.) (ANS. $P = 12.16 \text{ kN}$)

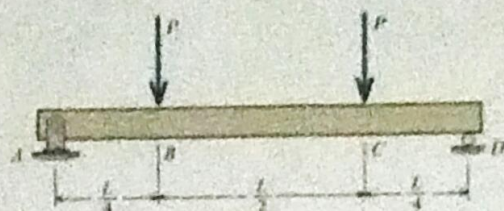


FIGURE P8.47a

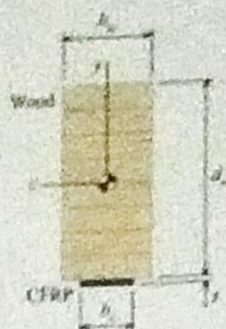
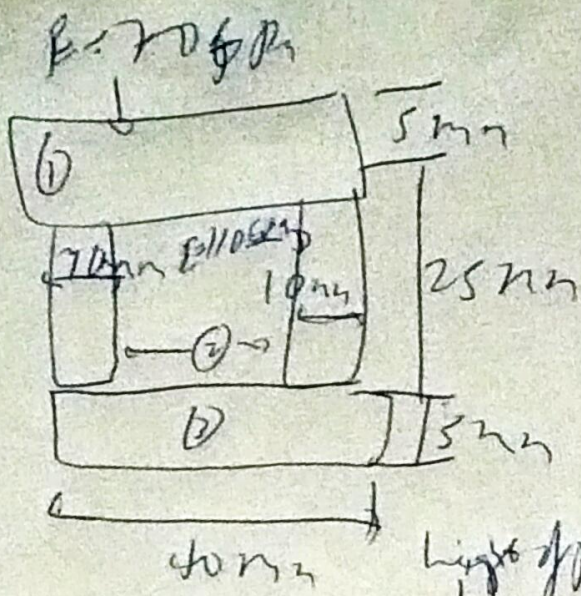
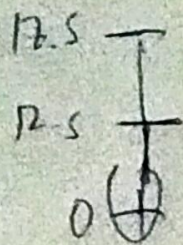


FIGURE P8.47b

1.



$$R = 380 \text{ N/mm}^2$$

$$= 380 \times 10^3 \text{ N/mm}^2$$

Part	R (GPa)	distance from bottom (mm)	h (mm)	b (mm)
1	70	30	5	40
2	10	5	25	6
3	70	0	5	40

$$\bar{y} = 17.5 \text{ mm}$$

$$I = 103110.12 \text{ mm}^4$$

$$\sigma' = \frac{M_c}{I}$$

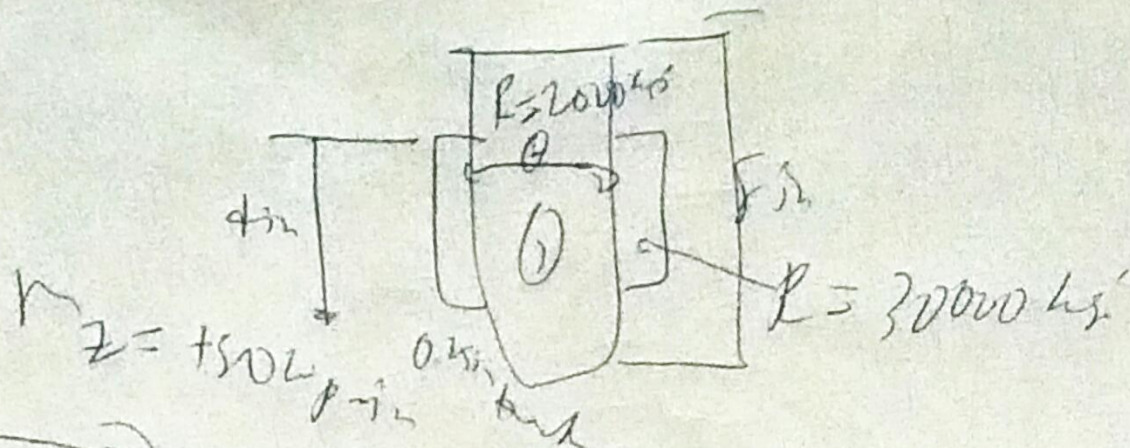
$$\sigma' = \frac{M_y}{I}$$

$$\sigma = n \sigma'$$

$$n = \frac{E_{\text{brass}}}{E_{\text{aluminum}}}$$

$\sigma_{\text{aluminum}} = 50.97 \text{ MPa}$
 $\sigma_{\text{brass}} = 56.65 \text{ MPa}$

2



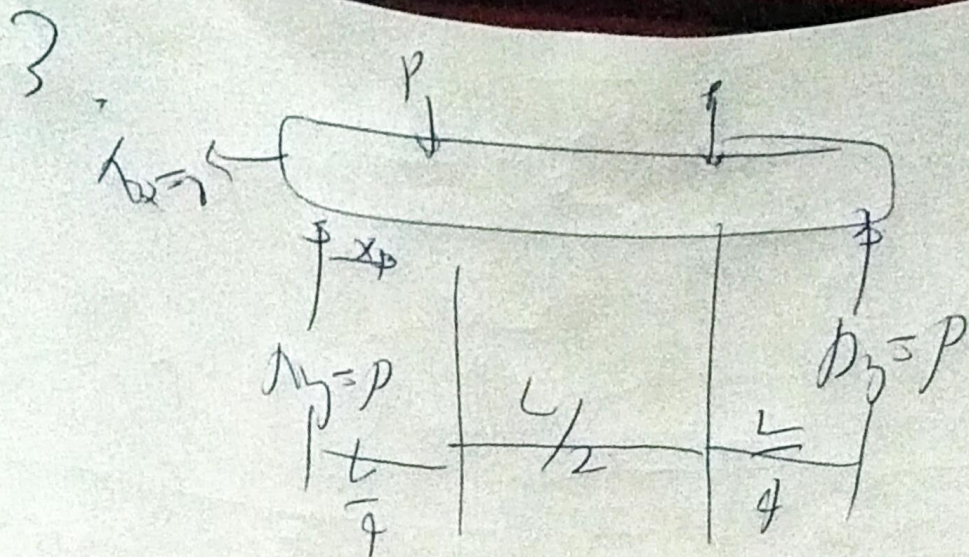
P	Part	E	height from bottom (in)	height to top (in)	distance of part (in)
1		2000	0	4	3
2		30000	2	4	0.5

$$h = 4 \text{ in}$$

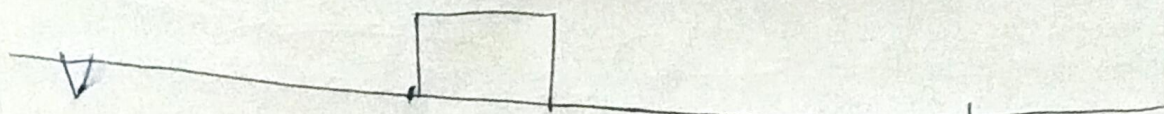
$$I = 168 \text{ in}^4$$

$$\max \sigma_{\text{wood}} = 1.19 \text{ ksi}$$

$$\max \sigma_{\text{steel}} = 5.93 \text{ ksi}$$



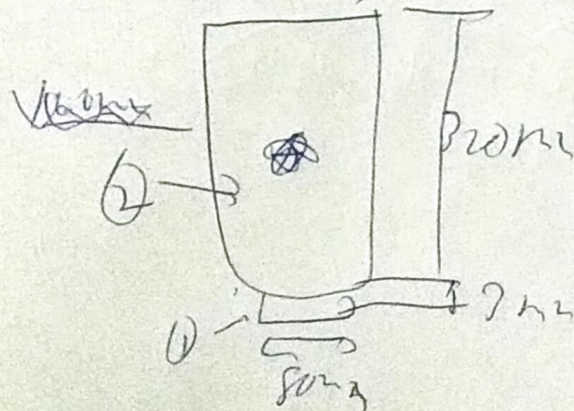
Net $P_x = P \left(x - \frac{L}{4} \right) - P \left(x - \frac{3L}{4} \right)$



$M \left(\frac{L}{4} \right) = P \left(\frac{L}{4} \right) - P \left(\frac{L}{4} - \frac{L}{4} \right) = P \left(\frac{L}{4} \right)$

Since $L/4 = L/4$: $M = 2P$

140 mm



$P_w = 16P_3$

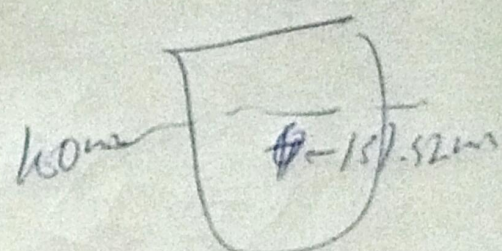
$P_{LFP} = 1656P_3$

$\sigma_{yw} = 9 \text{ MPa}$

$\sigma_{xLFP} = 1000 \text{ MPa}$

Label	height of bottom	height of top (m)	base of part (mm)
1	0 mm	3	80
2	2 mm	220	100

Label	method of choosing
1	(1000) / 65 GPa
2	12 GPa



$$\bar{y} = 151.52 \text{ mm}$$

$$I = 462462125.2 \text{ mm}^4 \quad p \approx \frac{h}{2}$$

$$\sigma' = \frac{B \cdot L}{I}, \sigma = n \sigma'$$

$$L_{GRP} = 151.52 \text{ mm}, L_{wood} = 171.08 \text{ mm}$$

$$\text{At } \sigma_{GRP} = 1000 \text{ MPa}, M = 221.75 \text{ kN-m} \Rightarrow P = 110.695 \text{ kN-m}$$

$$\text{At } \sigma_{wood} = 9 \text{ MPa}, M = 24.33 \text{ kN-m} \Rightarrow P = 12.1644 \text{ kN}$$

$$\therefore P = 12.16 \text{ kN}$$